Procedures to calculate PCB emissions from the Riverside Ag Park (DRAFT)

The whole modeling period is divided into five sub-periods:

a) Prior to Phase 1 cleanup: 1/2004 – 3/2009 right before the phase 1 clean up;
b) Phase 1 cleanup period: 4/2009 – 7/2009. **It is assumed that no PCB was emitted during the cleanup because of the extensive water suppression during the cleanup;**
c) Prior to Phase 2 cleanup: 8/2009 – 7/2013, right before the phase 2 cleanup period;
d) Phase 2 cleanup period: 8/2013 – 1/2014. **It is assumed that no PCB was emitted because of the extensive water suppression during the cleanup;** and
e) Post Phase 2 period: 2/2014 – 12/2015.

Because no PCB emissions are assumed to occur during the Phase I and 2 cleanup periods, these periods will not be modeled.

Based on the original request from DTSC, this analysis considers only the windblown emissions of PCBs from the park; vapor phase emissions of PCBs are not considered. Because PCB is emitted predominately by soil erosion in the park, it is reasonable to assume that the mechanism for PCB laden dust emissions is the same as that of the total suspended particulates (TSP). There is an important difference between PCB and TSP emissions: PCB emissions are high in patches of ground-level soil where PCB contents are high, and low in locations where PCB contents are low, while TSP emissions are approximately the same throughout the park.

PCB emissions are estimated in three steps. The first step is to estimate PCB concentrations in the soil from soil sampling data. The second step is to estimate TSP emissions based on meteorological data and soil type. The last step is to multiply TSP emissions by PCB concentrations in the soil to get PCB emissions.

1. Procedures to determine PCB concentrations in the park soil

The GIS geo-data provided by DTSC indicate a non-uniform PCB distribution for the post-Phase 2, 2015-2016 sampling in the Park (see Figure 1).

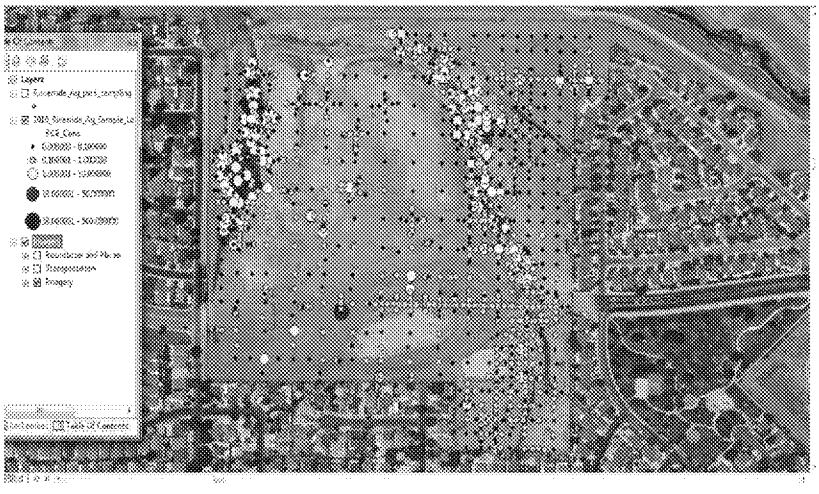

Figure 1. PCB distribution in the Park (post phase 2)

Based on the data and sampling locations shown in Figure 1, PCB concentrations in the soil will be estimated separately for five areas during each phase (see Figure 2):

Table 1. Five Areas used for PCB emissions estimation based on the soil sampling data

Area	Size	Description
A1	~ 3.4 acres	The area having high PCB concentrations in the eastern part of the park, shown in green
A2	~ 2.3 acres	The area having high PCB concentrations near the west edge of the park, shown in blue
A3	~ 15 acres	Area cleaned up in Phase 2 but not in Phase 1, shown in red
A4	~ 15 acres	Phase 1 cleanup area, shown in yellow
A5	~ 30 acres	The remaining areas within the park with near-zero PCB concentrations, shown in white

Figure 2. The five areas used for PCB emission estimation based on post-phase 2 sampling data. The numbers are PCB concentrations. Please note only concentrations greater than 1 mg/kg are shown.

For each area and each phase, PCB concentration in the soil is assumed to be uniformly distributed.

Because A1, A2 and A5 have never been excavated, PCB concentrations are assumed to be constant during all modeling periods. Average concentrations in those three areas for all phases are estimated from the post-

Phase 2 soil sampling data. The following table describes how average PCB concentrations are assigned to each area for all phases.

Table 2. Estimation of average PCB concentrations in five areas

A1	A1 has not been subjected to any cleanups so far, thus the average PCB concentration for all phases can be estimated from the post-Phase 2 soil sampling data. The average concentration is estimated to be [redacted].
A2	Similar to how the concentration is estimated for A1, the average PCB concentration in A2 is estimated to be [redacted].
A3	*The entire period up until Phase 2 cleanup* The average PCB concentration is assumed to be [redacted] because the Phase 1 cleanup area was determined to be anywhere with PCB concentrations greater than 50 mg/kg. The exact average concentration cannot be calculated from available data, so 50 mg/kg is solely based on the cleanup criterion.
	After the Phase 2 Cleanup Based on the soil sample data, the average PCB concentration is [redacted].
A4	*Prior to Phase 1 Cleanup* Assumptions: • The PCB concentrations outside of A3 have not changed throughout the modeling period. • The PCB concentration in A3 prior to Phase 1 was 50 mg/kg. • The average PCB concentration prior to Phase 1 for the entire park is 63.6 mg/kg. This is from a spreadsheet provided by DTSC, in the worksheet 'Summary' and the row for a sample depth of 0.5-2.5 ft. Calculations • Based on the post-Phase 2 soil sampling data, the average PCB concentration outside of A3 is 3.1 mg/kg. This simply relies on the fact that those areas were never excavated. • The acreage for the entire park is 65 acres. The acreage of A3 is 15 acres. The acreage of A4 is 15 acres. The acreage outside of A3 is 35 acres. • Since we have estimates of the average PCB concentration prior to the Phase 1 cleanup for areas A1, A2, and A3, as well as for the entire park, we can now calculate the average PCB concentration in A4, which is denoted by 'X' below: 63.6 * 65 = (X * 15) + (50 * 15) + (3.1 * 35) X = [redacted]
	Prior to Phase 2 Cleanup Assumption: • Each of the two cleanups reduced PCB concentrations with similar efficiency

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	Conclusion: • The PCB concentration for A4 is estimated to be [redacted] because the average concentration within A4 after the Phase 1 cleanup should be about the same as the post-Phase 2 cleanup level in A3.
	After Phase 2 Cleanup Based on the post-Phase 2 soil sampling data, the average PCB concentration is [redacted] (after 2nd excavation/cleanup).
A5	A5 has not been subjected to any cleanups, because the average PCB concentrations for all phases are very small. For the baseline analysis, concentrations in A5 will be set to zero.

Note: the sampling depth for post-phase 2 data is 0 - 0.5 ft, and the depth for pre-phase 1 data is 0.5 ~ 2.5 ft.

2. TSP emission rate calculations

TSP emissions are determined by the friction velocity, a micrometeorological parameter affected primarily by wind speed and secondarily by the vertical variation of temperature, and precipitation. For any hour with a measurable amount of precipitation (no less than 0.01 inch) recorded at the Riverside Municipal Airport, the TSP emission rate for that hour and the following five hours will be set to zero. For all other hours, hourly TSP emissions are calculated with a formula derived from wind tunnel soil dust measurement data (Macpherson et al, 2008, Journal of Geophysical Research, Vol. 113, F02S04):

$$E = 5.64 \times 10^{-12} u_*^{1.9744} \; in \; g/(cm^2 s)$$

where u_* is the friction velocity in cm/s (calculated from meteorological modeling). This formula, valid for an undisturbed surface, is taken from a 2008 Maricopa Co. PM_{10} Emission Inventory document. A correction factor of 100/52.3 has been applied to the formula so that the formula is valid for TSP other than PM_{10}. 52.3 is the percentage of PM_{10} in TSP for road and soil dust (US EPA, 1997, Guidance For Network Design and Optimum Site Exposure For $PM_{2.5}$ And PM_{10}, EPA-454/R-99-022).

It should be noted that methods for calculating an annual emission rate are not used here because they can't take the temporal variation of emissions into consideration. Examples of those methods include the US EPA's AP-42 and the ARB's method of estimating wind-blown dust from agricultural lands.

3. PCB emission rate calculation

As mentioned earlier, the PCB emission rate is calculated by multiplying the TSP emission rate by the PCB concentration in the soil. As such, the PCB emission rate varies hourly and by area in the park, and is determined by the friction velocity, precipitation, and PCB concentration in the soil.